

RECEIVED  
FSIS DOCKET ROOM

99 JAN -7 AM 10:15

44

# The Transfer of Protein Allergens From Latex Gloves

A STUDY OF INFLUENCING FACTORS

Donald H. Beezhold; David A. Kostyal; Jeffrey Wiseman, MD

**A**llergy to latex is on the rise among health care workers. The most common reaction to latex is the delayed-type hypersensitivity reaction (ie, type IV), primarily related to accelerators in latex (eg, mercapto-benzothiazole, tetramethylthiuram) and other chemicals.<sup>1</sup> Severe and life-threatening anaphylactic reactions do occur and have been seen in our institution, although the incidence is infrequent.<sup>2</sup> Immediate and anaphylactic reactions (ie, type I) appear to be an immunoglobulin E (IgE) mediated response to soluble proteins found in latex.<sup>3</sup>

Body sweat inside latex gloves may make

latex 'proteins soluble; the solubilized proteins are then absorbed through skin, sensitizing the wearer to the foreign protein. Latex protein absorption through the skin is postulated as the major route of occupational exposure for health care workers.' In addition, glove powder serves as a vector (ie, transport medium) for latex proteins.<sup>5</sup> Airborne latex proteins bound to this powder may become inhaled antigens and can inoculate surgical tissue and contaminate suture material, instruments, drapes, or sponges.<sup>6</sup> Although solubilization of latex proteins from latex gloves is well recognized, it is not known how quickly the latex antigens are transferred

*Donald H. Beezhold, PhD, is associate scientist and director of the Laboratory of Macrophage Biology at the Guthrie Research Institute, Sayre, Pa. He earned his bachelor of arts degree in biology from Trinity Christian College, Palos Heights, Ill; his master of science degree in anatomy from the University of Illinois, Chicago; and his doctorate in anatomy and cell biology from the University of Illinois, Chicago.*

*David A. Kostyal, PhD, is research associate in the Laboratory of Macrophage Biology at the Guthrie Research Institute, Sayre, Pa. He earned his bachelor of science degree in biology from St Joseph's College, Philadelphia; his master of science degree in microbiology from the University of Notre Dame, South Bend, Ind; and his doctorate in molecular biology from Wesleyan University, Middletown, Conn.*

*Jeffrey Wiseman, MD, is associate in surgery in the Department of Surgery at the Guthrie Clinic, Sayre, Pa. He earned his medical degree from the Medical College of Pennsylvania, Philadelphia.*

*The authors acknowledge William C. Beck, MD, FACS, FIES, president emeritus of the Guthrie Foundation for Education and Research, Sayre, Pa, and Margaret Furay Fay, RN, PhD, global affairs director/researcher, Regent Hospital Products, Ltd, Sarasota, Fla, for their helpful comments. They also acknowledge Zong-Lu Shen, Christine Personius, and Terrie Zintmer for excellent technical assistance. This study was supported by the Guthrie Foundation for Education and Research and a grant from Regent Hospital Products, Ltd, Greenville, SC.*

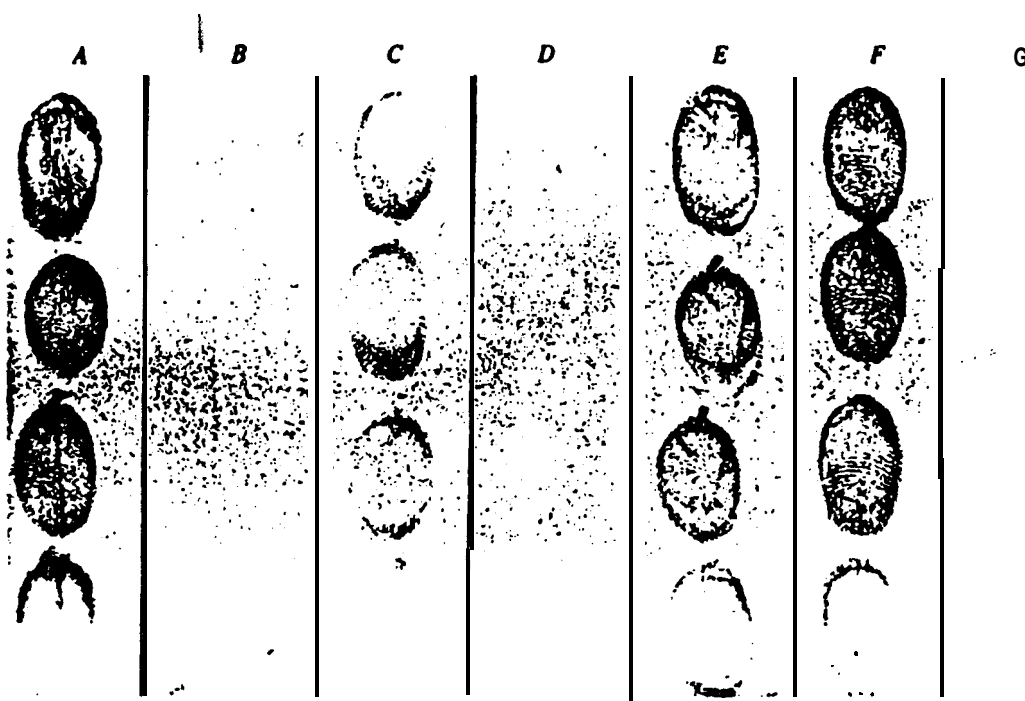


Fig 1. Comparison of protein transfer from latex gloves using fingerprint assay.

from the glove to the skin or mucous membranes of health care workers or patients.'

The purpose of our study was to examine factors that influence the transfer of protein allergens from latex gloves. We used an immunoblot technique (ie. immunologic method that identifies immobilized protein antigen) to visualize the latex protein transfer from latex gloves to skin and mucous membranes. The results of our study can serve as a practical guide for surgical staff members who wish to reduce their exposure to latex allergens and decrease the transfer of protein allergens to patients.

### Study Methods, Materials

We modified a latex protein immunoblot technique for use as a tool to examine the transfer of latex proteins from surgical gloves to moist membranes.<sup>1</sup>

**Fingerprint assay.** Nitrocellulose membrane was moistened with saline (pH 7.4) and then touched with the index finger of a latex-gloved

hand. The gloved finger was held in contact with the nitrocellulose membrane for three seconds and released. This process was repeated four times. The finger pressure was measured (ie, 5 lb/fingerprint) to ensure that equal pressure was exerted for each finger contact with the nitrocellulose. Proteins transferred from the latex gloves remained immobilized on the membrane because nitrocellulose binds proteins.

Additional protein binding sites were blocked with 5% dry milk protein, and the membranes were exposed to a 1:500 dilution of rabbit anti-latex antiserum or to a 1:50 dilution of human serum.<sup>2</sup> The human serum was a 1:50 dilution of blood from a latex-allergic subject who had experienced an anaphylactic reaction from glove contact during surgery. The rabbit anti-latex protein antiserum detects total latex antigen, whereas the human serum detects the IgE-reactive latex allergens.

A mouse monoclonal anti-human IgE was used to increase the sensitivity of the method to detect IgE allergens. Finally, the nitrocellulose membranes were reacted with alkaline phosphatase-labeled anti-rabbit or anti-mouse sera

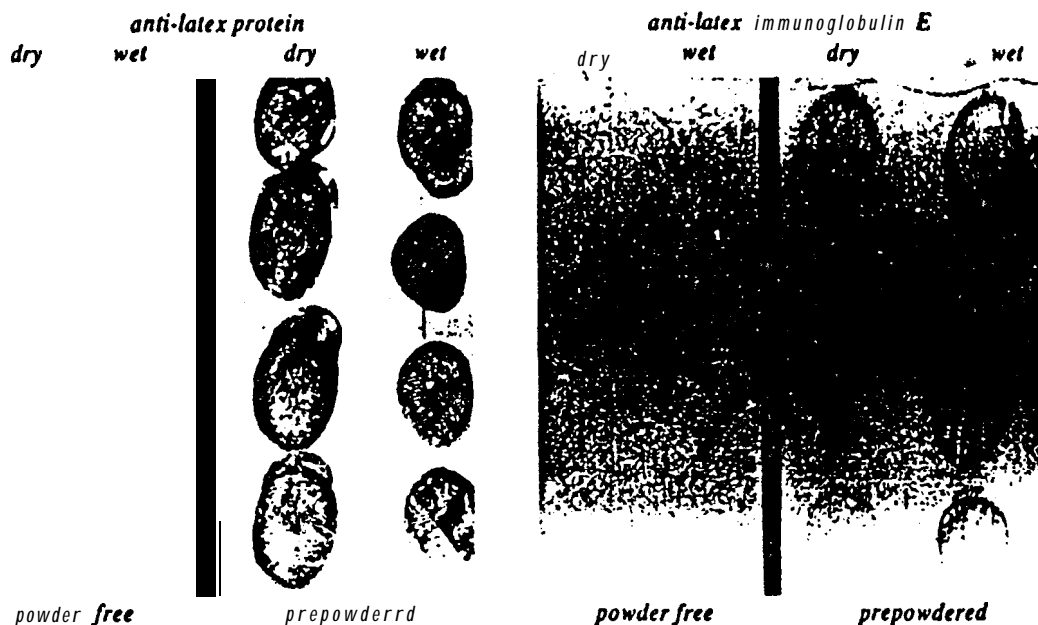


Fig 2. The prints on the left demonstrate that washing the gloves has no effect on the transfer of protein antigen to the nitrocellulose membrane. The prints on the right demonstrate that wiping gloves with saline-soaked sponges does not remove or reduce immunoglobulin E-reactive proteins.

and developed using nitroblue tetrazolium and bromo-chloro-indolyl phosphate as the enzyme substrate. The enzyme substrate produces a blue-purple reaction product that visually demonstrates fingerprint deposits of latex protein allergens.

**Gloves.** We tested seven brands of latex surgical gloves. A synthetic nonlatex glove served as the control. Figure 1 represents the following types of surgical gloves tested: A- powdered; B-powder free; C-low powder; D-low powder; E-powdered; F-powdered; and G—powder free.

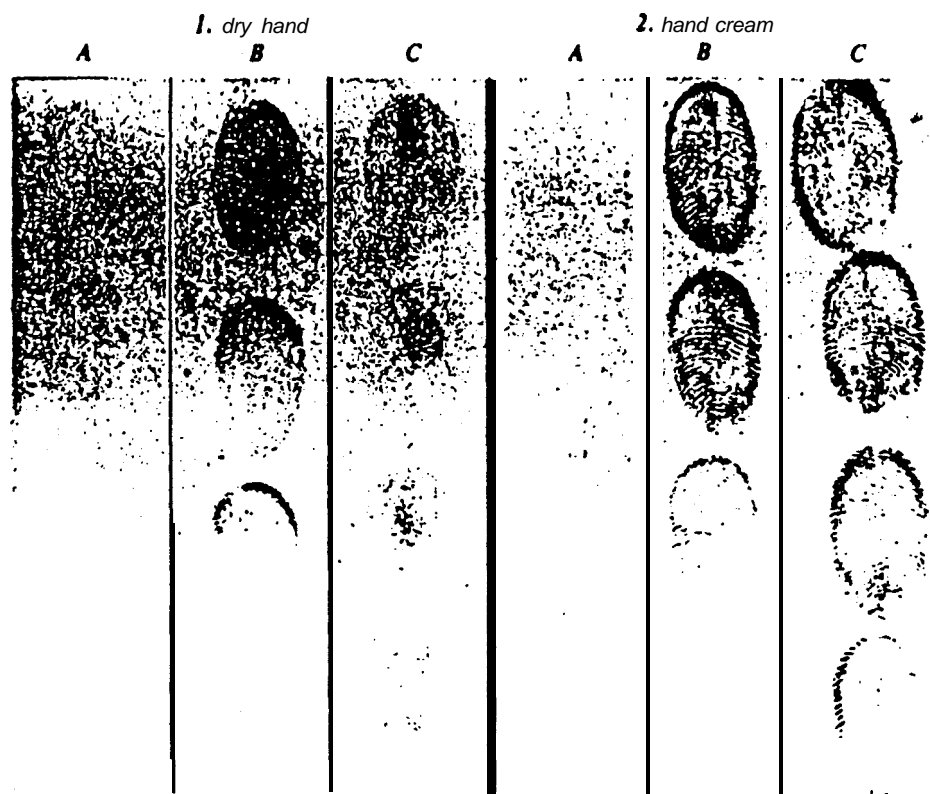
### Results

The seven brands of gloves deposited varying amounts of latex protein by the fingerprint technique. Column B shows results using a powder-free glove, and column D shows results using a low-powder glove. Very little protein transfer is seen in either column B or D. Variable protein transfer was observed in the other brands of gloves.

The membranes were only in contact with the latex gloves for three seconds; therefore, protein from the gloves was transferred immediately upon contact. Powder-free gloves had much lower levels of transferred proteins. This observation raised the question of whether powder played a significant role in the transfer of protein allergens.

**Glove washing.** We tested the efficacy of the recommended preincisional glove-washing procedure on the transfer of latex proteins. New surgical gloves were donned, the fingerprint test was repeated with the index finger of the right hand, and then the gloves were wiped with a saline-soaked, sterile sponge to reduce the amount of starch powder on the glove surface. The fingerprint process then was repeated using the washed gloved index finger of the left hand. This experiment was performed with both powder-free and prepowdered gloves. As shown on the left side of Figure 2, washing the gloves had no effect on the amount of protein antigen transferred to the membrane.

We then repeated this experiment, but this



**Fig 3.** Columns A represent washed, nongloved fingerprints (**ie**, the control). Columns B represent the gloved fingerprint, and **columns C** represent the fingerprint after wearing surgical gloves. This figure **compares dry, nonlotioned fingerprints on the left to lotioned fingerprints on the right**. In column 2-A, the fingerprints were made after washing the hand but **&fore applying the protective hand cream**; these prints demonstrate that washing removes the latex proteins from the skin. Comparisons between the prints in column 1-C and column 2-C demonstrate that hand cream increases the amount of latex protein transferred from gloves to hands.

time we used serum from a latex-sensitive patient as a probe for latex allergens. A similar pattern of **IgE-reactive** fingerprints is seen on the right side of the same figure, demonstrating that wiping surgical gloves with saline-soaked, sterile sponges is not sufficient to remove latex protein allergens.

**Protein transfer to hands.** Next, we tested the hypothesis that latex proteins **can** be transferred to the hand of the glove wearer. When a **washed, bare finger** initially was applied to the membrane prior to donning the glove, no fingerprints of latex protein were observed (Fig 3, column 1-A). Immediately following glove

removal, however, fingerprint testing demonstrated that considerable protein was left on the skin of the wearer (Fig 3, column 1-C).

**Protective hand cream.** Throughout the health care industry, it is becoming an increasingly common practice to apply protective hand **creams before** donning gloves. We tested the hypothesis that applying protective hand cream before donning surgical gloves **decreases** the amount of latex allergens transferred to the hands of the wearer. As shown in Figure 3 (**ie**, column 1-C **versus** column 2-C), hand cream actually increases the amount of latex protein that is transferred from gloves to the hands of

the wearer. Thus, if hands are not washed thoroughly after wearing surgical gloves, the latex proteins that remain on the skin can be transferred by the hand to any other surface.

### Summary

Latex proteins from surgical gloves have been shown to be potent allergens that elicit an IgE-immune response in certain individuals.<sup>10</sup> The routes of exposure to latex proteins are thought to include absorption through the skin or mucous membranes and inhalation of airborne particles.<sup>11</sup> It is argued that proteins are liberated from latex by body sweat during prolonged wearing of surgical gloves and that the protein allergens then are absorbed by the skin. The mechanisms of sensitization are not known.

In latex-sensitive individuals, immediate-type hypersensitivity reactions occur within 15 to 30 minutes after contact with latex.<sup>12</sup> This rapid reaction suggests the protein allergens must be released upon contact and may not require body sweat or prolonged exposure to liberate the latex protein from surgical gloves.

The fingerprint assay presented in this article visually demonstrates the potential of transferring allergenic proteins from latex gloves to the skin of the glove wearer. Our study examined several factors affecting the transfer of latex allergens (ie, the presence of glove powder, the effect of glove washing, the relationship of protective hand cream to latex protein transfer).

Surgical gloves are known to differ in their soluble protein content. It was no surprise, therefore, that different brands of gloves varied in the amount of protein transferred upon contact.<sup>13</sup> It was surprising, however, to observe that the proteins are transferred from latex surfaces immediately upon contact with the moist skin membrane. The fingerprint technique demonstrates that considerable proteins exist on the surface of the gloves and that body sweat is not necessary to liberate them.

We examined the practice of glove washing to remove lubricant powders and found that washing did not reduce the amount of protein

that was transferred to the membrane. While glove powders do carry the latex protein allergens, surface proteins can be transferred directly by contact with latex alone.<sup>14</sup> The wiping procedure, therefore, is inadequate to remove glove powder and latex proteins.<sup>15</sup>

We also examined the transfer of latex proteins to the skin of the glove wearer. Significant amounts of latex protein coated the skin simply by donning the glove. Furthermore, applying protective hand creams before donning gloves appeared to increase the amount of latex protein on the skin. Although the use of hand creams helps maintain a healthy integument, these creams should be used judiciously, because oil-based creams can deteriorate latex, thus causing a change in the physical characteristics of latex gloves.

### Recommendations for Practice

In conclusion, we recommend that hand creams be used only when gloves are not worn. Hands should be washed immediately after removing gloves to eliminate latex proteins from the skin and prevent latex protein transfer to mucous membranes of the eyes, nose, or mouth. Hand washing after glove removal also prevents transfer of latex proteins to other surfaces (eg, door knobs, telephones, instruments) where they may be contacted by latex-sensitive individuals.

The demonstration of latex protein transfer with the fingerprint assay is an important reminder of the need to understand that allergens are in or on gloves and how they are absorbed by the wearer or transferred to the patient. Transfer of allergenic proteins from the gloves to the tissues during surgery can serve as a primary source of sensitization of the patient. We recommend that every effort be made by manufacturers to produce low-protein, powder-free gloves to minimize exposure to latex protein allergens. □

### Notes

1. A Heese et al. "Allergic and irritant reactions to rubber gloves in medical health services," *Journal*

of the American Academy of Dermatology 25 (November 1991) 83-839.

2. V J Tomaric et al. "Latex-associated allergies and anaphylactic reactions," *Clinical Immunology and Immunopathology* 64 (August 1992) 89-97; D R Owenby et al. "Anaphylaxis associated with latex allergy during barium enema examinations," *American Journal of Roentgenology* 156 (May 1991) 903-908.

3. T Carrillo et al. "Contact urticaria and rhinitis from latex surgical gloves," *Contracr Dermatitis* 15 (August 1986) 69-72; C Morales et al. "Anaphylaxis produced by rubber glove contact: Case reports and immunological identification of the antigens involved," *Clinical and Experimental Allergy* 19 (July 1989) 425-430; G L Sussman, S Tarlo, J Dolovich. "The spectrum of IgE-mediated responses to latex," *Journal of the American Medical Association* 265 (June 1991) 2844-2847.

4. D Beezhold, "Latex allergy," *Biomedical Instrumentation and Technology* 26 (May 1992) 238-240; Tomazic et al. "Latex-associated allergies and anaphylactic reactions," 89-97.

5. X Baur, D Jager, "Airborne antigens from latex gloves," *The Lancet* 335 (April 1990) 912; K Turjanmaa et al. "Allergens in latex surgical gloves and glove powder," *The Lancet* 336 (December 1990) 1588; D Beerhold, W C Beck. "Surgical glove powders bind latex antigens," *Archives of Surgery* 127 (November 1992) 1354-1357.

6. Beezhold, Beck, "Surgical glove powders bind latex antigens," 1354-1357.

7. D Beezhold, "LEAP: Latex ELISA for antigenic proteins," *The Guthrie Journal* 61 (Spring 1992) 77-81.

8. Beezhold, Beck. "Surgical glove powders bind latex antigens," 1354-1357.

9. *Ibid.*

10. J-G Axelsson, S G Johansson, K Wrangsjö. "IgE mediated anaphylactoid reactions to rubber," *Allergy* 42 (January 1988) 46-50; P J Frosh et al, "Contact urticaria to rubber gloves is IgE-mediated," *Contact Dermatitis* 14 (April 1986) 241-245; J E Slater, L A Mosrello, C Shaer. "Rubber-specific IgE in children with spina bifida," *Journal of Urology* 146 (August 1991) 578-579; Carrillo et al. "Contact urticaria and rhinitis from latex surgical gloves," 69-72; Morales et al. "Anaphylaxis produced by rubber glove contact: Case reports and immunological identification of the antigens involved," 425-430; Sussman, Tarlo, Dolovich. "The spectrum of IgE-mediated responses to latex," 2844-2847.

11. I. Beezhold. "Latex allergy," 238-240; Axelsson, Johansson, Wrangsjö, "IgE mediated anaphylactoid reactions to rubber," 46-50; V J Tomazic et al. "Latex-associated allergies and anaphylactic reactions," 89-97.

12. J Laurent et al. "Latex hypersensitivity after natural delivery," *Journal of Allergy and Clinical Immunology* 89 (March 1992) 779-780; F Leynadier, C Pequet, J Dry, "Anaphylaxis to latex during surgery," *Anesthesia* 44 (July 1989) 547-550; D R Owenby et al, "Anaphylaxis associated with latex allergy during barium enema examinations," 903-908.

13. Beerhold, "LEAP: Latex ELISA for antigenic proteins," 77-81.

14. Bauer, Jager, "Airborne antigens from latex gloves," 912; Turjanmaa et al. "Allergens in latex surgical gloves and glove powder," 1588; Beezhold, Beck. "Surgical glove powders bind latex antigens," 1354-1357.

15. H Ellis, "The hazards of surgical glove dusting powders," *Surgery* 171 (December 1990) 521-527.

## First-Time Fathers Active in Infant Care

A study of 53 first-time fathers and 69 multiple-time fathers (ie. fathers with more than one child) concludes that a father is more likely to be active in his infant's care if he is a first-time father. The study, published in the December 1993 issue of the *International Journal of Nursing Studies*, reports that first-time fathers are more likely to play with their infants, change diapers, comfort their infants, and encourage vocalizations. The findings are based on performance reports from the fathers and mothers in both research groups.

Although the multiple-time fathers in the study knew how to take care of babies, their performance levels were significantly lower than their wives' expectations and significantly lower than the performance levels reported by first-time fathers. The researchers hypothesize that first-time fathers are more involved in child care because society's expectations for fathers are higher now than ever.